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BOOKS AND SOFTWARE IN REVIEW

Kazuma Mawatari, Takehiko Tsukahara, Yo Tanaka, Yutaka Kazoe, Philip Dextras and Takehiko Kitamori: Extended-nanofluidic systems for chemistry and biotechnology

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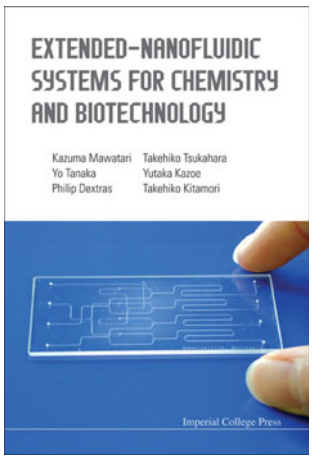

Bibliography
Extended-nanofluidic systems for chemistry and biotechnology
Kazuma Mawatari, Takehiko Tsukahara, Yo Tanaka, Yutaka Kazoe, Philip Dextras and Takehiko Kitamori
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Book's topic Lab-on-chip technology continues to develop into an extensively used technology with applications in analytical and synthetic chemistry, biology, pharmacy, diagnostics, and medicine. In the commonest applications, lab-on-chip systems are used for advanced sample handling and treatment, which includes fluidic samples and objects such as particles and cells. Typical feature sizes are in the range of 10–300 μm. In the last decade, owing to improved fabrication technologies, systems with dimensions below micrometers have become accessible to a larger community of researchers. These tiny dimensions give rise to interesting, unpredicted phenomena. *Extended-nanofluidic systems for chemistry and biotechnology* addresses the dimension between nanofluidic and microfluidic technology; it leads the reader into the space with intermediate dimensions, where fluidics and chemistry are largely unknown. These transient spaces between single molecules and the bulk condensed phase provide fascinating opportunities for basic research and practical use.

Contents The book consists of eight chapters, each of which contains a comprehensive literature list for further reading. After a general introduction (Chap. 1), the reader is introduced to the concepts of microchemical systems (Chap. 2). Although short, this chapter provides a good overview of standard chemical processes such as mixing, extraction, and separation that have been realized on a microfluidic device. Chapter 3 is concerned with the fabrication processes. The authors describe various choices of materials and fabrication methods, and additionally they have included approaches for surface modification and bonding of the bulk substrate with cover materials.

In integrated microchemical systems, fluid control is an essential requirement. In Chap. 4, the basic theory and different flow control methods are described. Among them, electroosmotic flow is usually chosen to transport liquids through (extended-) nanofluidic channels owing to the easy operation. With the sample introduced into and transported along the channels, detection and imaging methods are required to monitor the sample inside the channels. In Chap. 5, various optical and electrochemical methods to detect (single) sample molecules and to determine fluidic properties are discussed.

Chapter 6 and 7 describe basic and applied studies that have been performed with extended-nanofluidic systems, mainly by the authors' group. For example, fundamental investigations revealed that the viscosity of water is increased and proton mobility is enhanced in such small confined spaces. These are interesting findings since altered liquid properties can influence the kinetics of a chemical

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reaction, which is illustrated in several examples. More applied studies are concerned with the separation performance of extended nanochannels and their use in combination with immunoassays and DNA analysis.

In their conclusion (Chap. 8), the authors emphasize the difference between extended-nanospace systems and microfluidic systems, where basically all physicochemical properties of the liquids are unchanged compared with macroscopic systems. In contrast, extended nanospaces are an interesting transition area, which may be the basis for more innovative nanochemical and nanobiochemical devices.

Comparison with the existing literature The book focuses on the particular dimensions between conventional microfluidic and nanofluidic systems and hence complements the existing literature in this area, e.g., *Introduction to microfluidics* by P. Tabeling (Oxford University Press, 2005) and *Microsystem engineering of lab-on-chip devices,* edited by O. Geschke, H. Klank, and P. Telleman (Wiley-VCH, 2008). In contrast to most books in this research field, which are collections of review articles describing recent studies, the authors provide a textbook written in a consistent style.

Critical assessment *Extended-nanofluidic systems for chemistry and biotechnology* is written in a clear and straightforward style, and the chapters are nicely illustrated with several figures. The book covers the fundamental aspects required for understanding such systems, as well as useful practical information which should be considered when working with these systems. It contains a lot of general information for students and newcomers to the field, which applies not only for extended-nanospace systems as indicated by the title, but is also important for microfluidic and nanofluidic systems in general. Additionally, researchers familiar with microfluidic or nanofluidic systems will be particularly stimulated by the findings and applications described in Chaps. 6 and 7.

Summary *Extended-nanofluidic systems for chemistry and biotechnology* is a textbook covering general fundamental and practical aspects of microfluidic, nanofluidic, and extended-nanofluidic systems. It is short and focused and hence makes it possible for one to quickly gain an overview of such systems, without searching in the vast number of original articles. For further detailed reading, numerous additional references are listed at the end of each chapter. The interesting application examples given in the final two chapters highlight the potential of extended nanofluidics and ignites the reader's curiosity with regard to the particular properties of extended nanospaces.